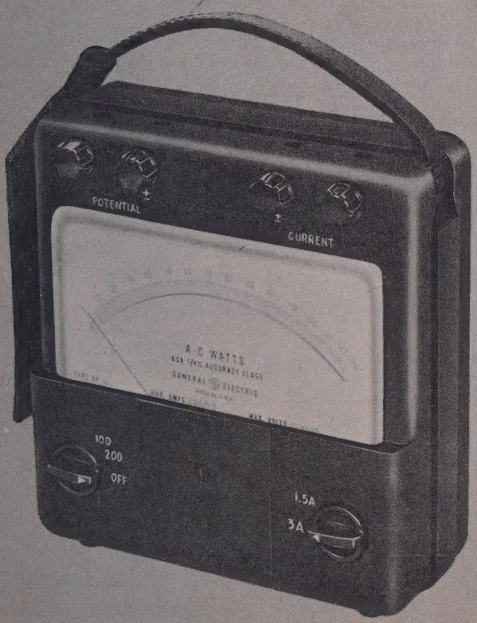
INSTRUCTIONS

GEJ-2416

TYPES AP-11 AND AP-12
A-C
PORTABLE INSTRUMENTS

EXTRA COPY



GENERAL ELECTRIC

TABLE OF CONTENTS

	Page
INTRODUCTION	3
RECEIVING, HANDLING, STORAGE	4
OPERATION	4
TEMPERATURE CORRECTIONS	4
READING POSITION	4
ZERO ADJUSTMENT	5
POLARITY	5
USE ON D-C CIRCUITS	6
CONTINUOUS OPERATION	6
USE OF RANGES AND SCALES	6
VOLTMETER	7
Connections	7
Extension of Range	8
AMMETER	9
Connections	9
Extension of Range	12
WATTMETER	13
Connections	13
Extension of Range	18
MAINTENANCE	19

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TYPES AP-11 AND AP-12 PORTABLE INSTRUMENTS

INTRODUCTION

Your General Electric Type AP-11 or AP-12 portable a-c ammeter, voltmeter, or wattmeter is a high-precision instrument. The Type AP-12 has an American Standards Association accuracy rating of ¼ percent, and thus conforms to the ASA Standard C39.1, accuracy class 0.25. The Type AP-11 has an accuracy of ½ percent (ASA accuracy class 0.5).

These instruments are shielded from the effects of external magnetic fields by means of high-permeability steel shields. The ammeter and voltmeter are instruments of the iron-vane repulsion type with vanes of a low-hysteresis, high-permeability alloy. The wattmeter is an electrodynamic instrument. The moving element carries a pair of coils excited by the potential. The field is produced by the current flowing through a pair of fixed field coils.

A "certification" tag is supplied with each Type AP-12 instrument. This tag includes the following information: type of instrument, serial number, rating, certified accuracy, internal resistance of voltmeters and wattmeters, and temperature coefficient. No certificate is supplied with the Type AP-11 instrument. Resistance data is found on the scale. The scales of Type AP-11 & -12 instruments are 5½-inches long.

The "Textolite" molded case has a transparent plastic window. The case dimensions are: 7-55/64 in. high, 7-3/8 in. wide, and 3¼ in. deep. These dimensions include the rubber feet but not the leather strap handle which is attached to each instrument for ease in handling.

*Reg. Trade-mark of the General Electric Company

RECEIVING, HANDLING AND STORAGE

Immediately on receipt of your Type AP instrument, examine it for any damage which may have occurred in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company, and the nearest General Electric apparatus sales office should be notified promptly.

Electric indicating instruments are of necessity delicate, and reasonable care is required when handling or transporting them. Never carry more than one instrument in each hand at a time. If not carried, the instrument should be packed in the original cartons when transported. If these are unavailable, pack in three or four inches of excelsior. During shipment they should be placed either topside down or on edge. In the first case, there is little likelihood of "stickiness" developing because the shocks are transmitted to the top pivot and jewel. In the second case, the stresses are carried by the sides of the two pivots and usually there is little likelihood of injuring the delicate pivot ends.

If storage is to be in an area of continuous, even though slight, vibration, the instruments should be placed topside down or on edge for the reasons indicated above.

OPERATION

TEMPERATURE CORRECTIONS

Type AP-11 and -12 instruments are usually compensated for errors resulting from ordinary changes in temperature. In using the Type AP-12 where precise results are required and the instrument is subjected to extreme temperatures, the correction factor, which is given in the certificate, should be considered.

READING POSITION

The instrument is designed to be used in a level position(face up); although highly accurate leveling is not necessary.

The instrument may be used at angles up to 45 degrees or even in the vertical position; however, this is not recommended when results of the highest accuracy are required.

ZERO ADJUSTMENT

If, with no current flowing through the instrument, the pointer is not on zero, adjust it by means of the zero-adjusting screw located on the front of the instrument.

If the pointer is bent, due to severe overloading, it can be corrected by a competent instrument repair man or returned to the factory, General Electric Company, 40 Federal Street, West Lynn 3, Massachusetts, after first obtaining a RETURNED APPARATUS tag from the nearest sales office of the General Electric Company. After straightening the pointer, check the calibration of the instrument.

POLARITY

Type AP-11 and -12 voltmeters have one post marked "±" and this should be connected to the grounded side of the line under test if the line is grounded. If there is more than one scale range, each of the other binding posts is marked by engraved numbers on the cover.

Type AP-11 and -12 wattmeters have a "±" mark near one potential post and also near one current post. These two points should be connected to the same side of the line, preferably the grounded side, and therefore, will be at substantially the same potential. In some polyphase testing it is necessary at times to reverse one connection. This should be the current connection. This prevents undue voltage differences between the armature and field coils.

USE ON D-C CIRCUITS

If high accuracy is required when using Type AP-11 or AP-12 instruments on d-c circuits, the results should be obtained by averaging the indications obtained with reversed polarities. To do this with ammeters and voltmeters, interchange the two leads. With

wattmeters, it is necessary to change the polarity of the circuit by changing the current leads.

CONTINUOUS OPERATION

A-c voltmeters and wattmeters have special potential circuits to permit their use in circuit continuously without serious error resulting. However, it is recommended that the leads be disconnected during long sustained tests when readings are not actually being made. If the instrument is supplied with a potential switch, use this to open the circuit.

The ammeters have extremely small self-heating errors, but it is recommended that they be short circuited when indications are not being taken.

USE OF RANGES AND SCALES

Type AP-11 and -12 ammeters, single range, have no terminal post markings. The scale range indicates the instrument rating. In special cases where the scale is marked other than the instrument rating, the binding posts will be marked with the instrument rating. Double range ammeters are supplied with a range switch and the position of the switch knob indicates the range.

It is important to note that the scales of a-c ammeters and voltmeters are of necessity non-uniform and congested in their lower values. Also, that the accuracy figures credited to the instrument are given in terms of the full-scale value. It is apparent, then, that readings taken at different points on the scale will vary in the percentage of their absolute accuracy. For example, on a voltmeter of 100-volt range which is marked in one-volt intervals, 1/10 division is 1/10 volt. At 100 volts, an error of this amount corresponds to 1/10 percent; but at 50 volts it would be 1/5 percent while at 10 volts, it has risen to 1 percent.

Thus, for high accuracy results the scale ranges of the instruments should be chosen to give indicated values above 1/2 full scale, or for very important tests, above the 2/3-scale point. For instance, if the voltage of a nominal 120-volt circuit is being check-

ed, an instrument of 150-volt range should be used in preference to one of 300-volt full scale.

When using a multiple range instrument to measure an unknown current or voltage, try the highest range first. If the indication is too low for an accurate reading use a lower scale range.

The scale on these instruments is designed for quick, accurate readings. The mirror behind the pointer is used to prevent parallax. When taking a reading, the eye should be directly over the pointer so that the reflection of the pointer is completely covered by the pointer itself.

In some cases, it is not practical to mark all ranges on the scale. In this event, the lowest scale should be used and the reading then multiplied by the proper multiplication constant.

$$\text{multiplication constant} = \frac{\text{marking on terminal used}}{\text{full-scale value of lowest range}}$$

VOLTMETER

CONNECTIONS

Voltmeters are high-resistance instruments and should be connected across the load as shown in Fig. 1.

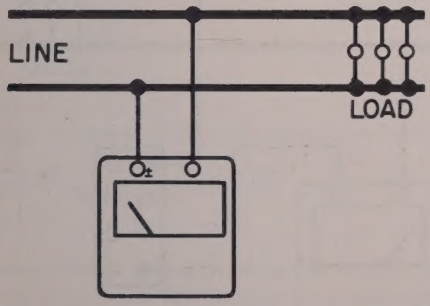


Fig. 1. Voltmeter connected across load

Voltmeters having a range of 15 volts or lower are calibrated and supplied with 0.03-ohm leads. For accurate results these leads should always be used with the instrument.

EXTENSION OF RANGE

It is possible to extend the range of voltmeters by the use of multipliers (external resistances). Unless these are Type YR multipliers built for use with these instruments, care should be taken to see that they are non-inductive, of sufficient current capacity, well insulated for the circuit voltage to which they are connected, and wound of wire having a negligible temperature coefficient.

When used, the indications of the instrument should be multiplied by the following constant:

$$K = \frac{\text{Resistance of Instrument} + \text{Resistance of Multiplier}}{\text{Resistance of Instrument}}$$

Fig. 2 shows these connections.

Warning: If one side of the line is grounded, the instrument should be connected to that side to avoid high potentials between the instrument and ground.

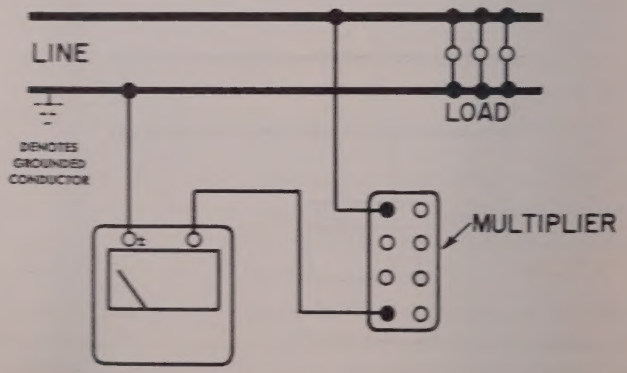


Fig. 2. Connections for voltmeter and multiplier

Care should be taken to connect the multiplier to the range of the voltmeter for which it was built. This is usually the lowest range. When voltages of over 300 volts are to be measured the use of instrument-potential transformers is recommended rather than multipliers, although multipliers can be furnished for as high as 750 volts. When voltages of 750 volts and higher are to be measured, it is strongly urged that instrument potential transformers be used to protect the instrument and the operator. Connections for using a potential transformer with a voltmeter are shown in Fig. 3.

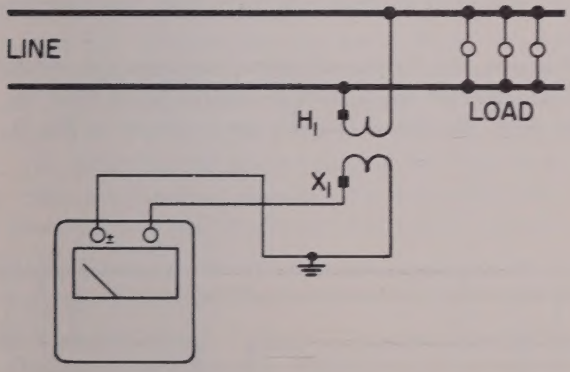


Fig. 3. Voltmeter used with potential transformer

AMMETER

CONNECTIONS

Since an ammeter is an instrument of very low resistance, it should never be connected across the load, but always in series with it. The following diagrams show methods of connecting.

Fig. 4 shows an ammeter connected in power circuit.

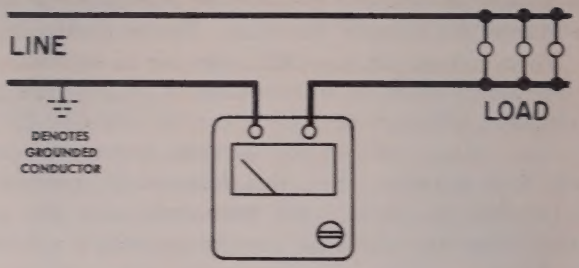


Fig. 4. Ammeter connected in power circuit

Warning: If either side of the line is grounded, the instrument should be connected in that side to protect the instrument and operator.

As shown in Fig. 5, the voltmeter measures the voltage across the ammeter plus the load. This is slightly larger than the voltage across the load. An alternative scheme is shown in Fig. 6.

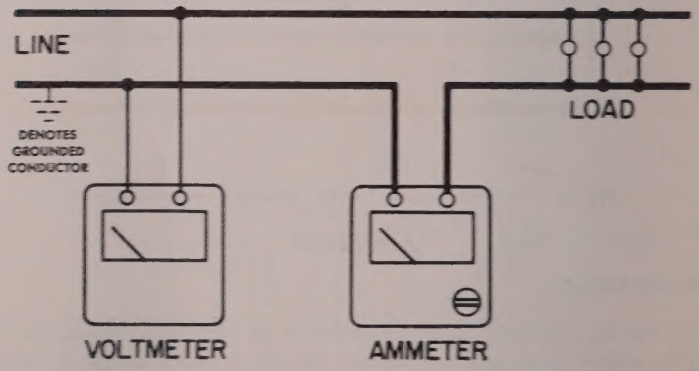


Fig. 5. Voltmeter and ammeter in power circuit

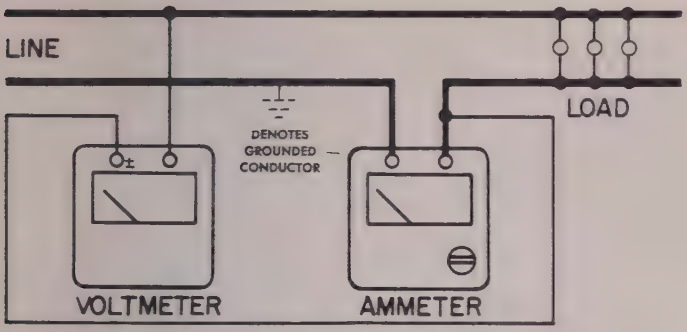


Fig. 6. Voltmeter and ammeter in power circuit

With the connections shown in Fig. 6, the ammeter measures the current in the voltmeter plus the load. If the current is fairly large (10 amperes or above) this current will be of small moment except for tests of extremely high precision. If the load circuit is non-inductive the voltmeter current can be subtracted out directly. If inductive, the phase angle of the load must be considered. For all practical purposes the voltmeter can be considered non-inductive and its current computed from the data on the scale.

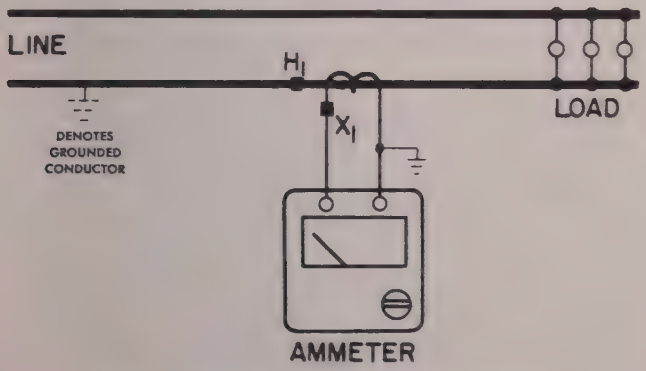


Fig. 7. Ammeter with current transformer

EXTENSION OF RANGE

The range of ammeters may be extended by the use of instrument current transformers. Connections should be as shown in Fig. 7, page 11.

Current transformers are also suggested on circuits where conditions are hazardous as they effectively insulate the instrument from high voltages. Standard current transformers are built for a secondary current of 5 amperes and may be used with any AP-11 or -12 instrument having a 5-ampere range.

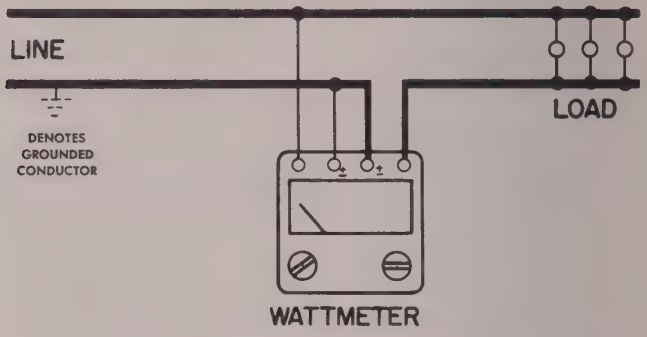


Fig. 8. Wattmeter in single-phase circuit

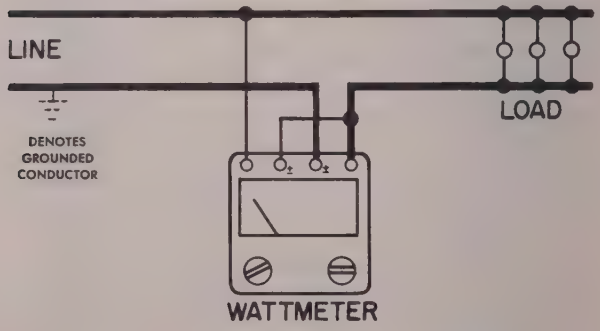


Fig. 9. Wattmeter in single-phase circuit

WATTMETER

CONNECTIONS

It is advisable to protect wattmeters from overload by first trying the circuit with voltmeters and ammeters. Fig. 8 to 13, inclusive, show the proper methods of connection.

As shown in Fig. 8, the wattmeter measures the power loss in its own current circuit plus the power in the load. An alternate scheme is shown in Fig. 9.

The "±" post of the potential circuit should always be connected to the same side of the line as the current leads. This is necessary to prevent electrostatic forces between the armature and surrounding parts. If, on connecting, the instrument is found to be reversed (to indicate backward) the current leads should be reversed to make the instrument indicate properly.

When connected as shown in Fig. 9, the wattmeter measures the loss in its potential circuit plus the power in the load. However, this potential loss can be subtracted out directly when the precision of the results warrants. (With loads of 10,000 watts or greater, this correction is inappreciable.) The loss in the potential circuit can be computed from the scale data as

$$\text{Watts Loss} = \frac{E^2}{\text{Resistance of Potential Circuit}}$$

when "E" is the voltage of the line.

With the connections shown in Fig. 10 the voltage is that across the wattmeter current circuit plus the load, and the watts indicated by the wattmeter are also the power in the wattmeter current circuit and the load.

With the connection shown in Fig. 11 the voltage indicated is that directly across the load. However, the wattmeter indication is too high as it is the sum of the loss in the load plus the losses of the voltmeter and the potential circuit of the wattmeter. The indication can be corrected by subtracting these instrument losses

out of the indication as pointed out in discussing the connections in Fig. 9.

Connection diagram Fig. 12 is similar to Fig. 10. The same remarks apply to it. The wattmeter indicates the power load plus its own current-coil loss plus the loss in the ammeter. For most purposes these latter are too small to consider. An alternate scheme is shown in Fig. 13.

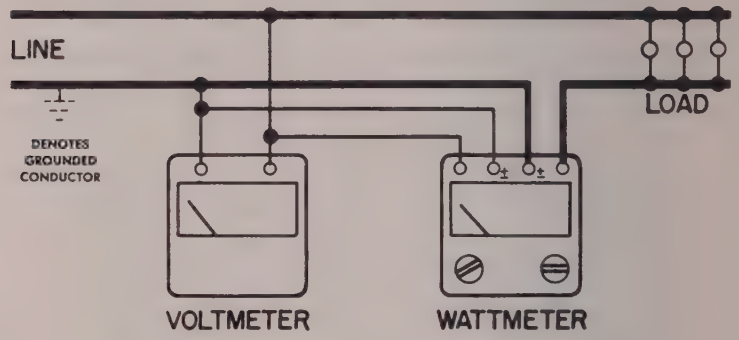


Fig. 10. Voltmeter and wattmeter in power circuit

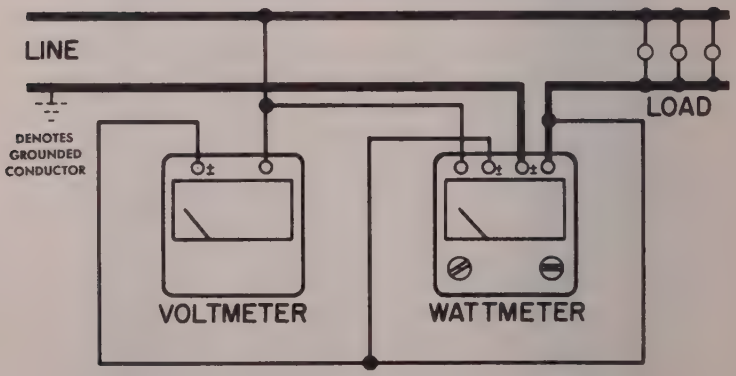


Fig. 11. Voltmeter and wattmeter in power circuit

With the connections shown in Fig. 13 the wattmeter indications are the sum of the power losses of the load, the potential circuit of the wattmeter and the voltmeter. See Fig. 9 and 11. An easy correction can be applied for these instrument losses. The ammeter also indicates the sum of the load current plus the currents in the voltmeter and in the potential circuit of the wattmeter.

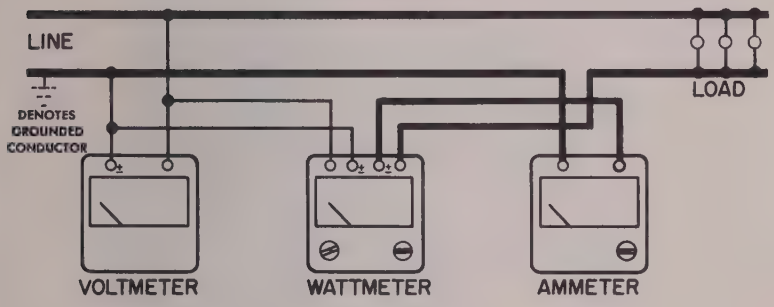


Fig. 12. Voltmeter, wattmeter, and ammeter in power circuit

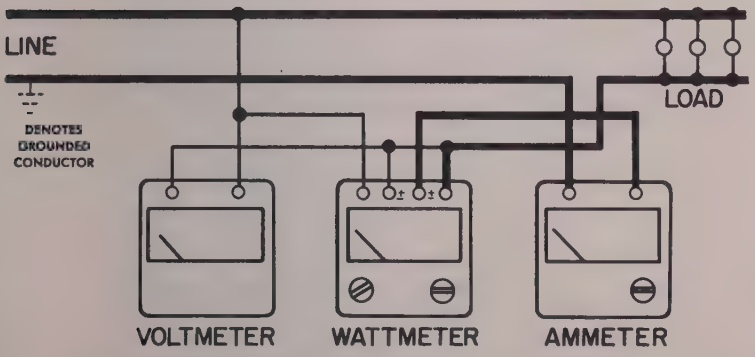


Fig. 13. Voltmeter, wattmeter, and ammeter in power circuit

With the connections shown in Fig. 12 or 13 the power factor of the circuit can be determined. It is

$$\text{Power Factor} = \frac{\text{Watts}}{\text{Volts} \times \text{Amperes}}$$

"Watts" in this case is the wattmeter reading minus the loss in current or voltage circuits, depending on the method of connection.

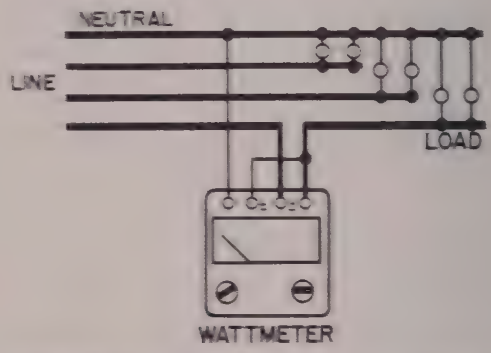


Fig. 14. Single-phase wattmeter in balanced 3-phase, 4-wire circuit

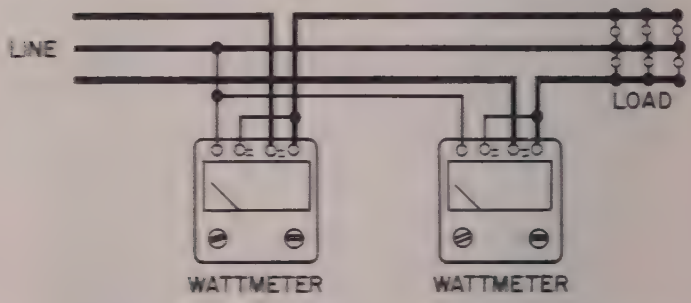


Fig. 15. Two wattmeters connected for 3-phase balanced or unbalanced voltages or load

For tests on polyphase power circuits, the connections shown in Fig. 14 to 16, inclusive, are used. These are shown only for the wattmeter as it should be understood that ammeters and voltmeters can be connected into these circuits in accordance with the preceding diagrams.

The power of the system is three times the indication of the wattmeter when connected as shown in Fig. 14. The wattmeter indicates its own potential losses plus those of one phase of the load. This potential circuit loss can be corrected out (See Fig. 9 and 11) or the wattmeter can be connected as in Fig. 8 or 10.

In general, the two wattmeters connected as shown in Fig. 15 will not indicate alike, even if the load is balanced. The true power is the sum of the indications of the two wattmeters, at power factors of 0.5 or over. At 0.5 power factor, one wattmeter indicates zero and the other the total power in the circuits. Below 0.5 power factor, one wattmeter will read backward. To make it read correctly, interchange the current leads. The smaller reading must then be subtracted from the larger. The current leads should be reversed so that the zero of the potential circuit will be at the same potential as the current coils in the instrument. This is necessary to prevent electrostatic forces on the armature.

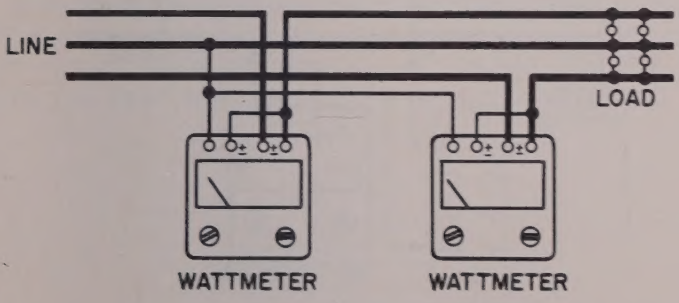


Fig. 16. Two wattmeters for 2-phase, 3-wire balanced or unbalanced load

Two wattmeters connected as in Fig. 16 are generally used for measuring 2-phase, 3-wire, balanced or unbalanced loads. The power is the sum of the indications of the wattmeters. If the load is known to be balanced, one wattmeter alone may be used and its indication multiplied by 2 to get the true power of the system.

EXTENSION OF RANGE

The range of wattmeters may be extended by the use of multipliers or instrument potential transformers in the potential circuit and by the use of current transformers in the current circuit, or both. The precautions to be taken are similar to those necessary when using the same methods for extending the ranges of voltmeters and ammeters.

When multipliers are employed which are not Type YR multipliers built for use with these instruments they should be non-inductive, of a sufficient current rating, and well insulated and wound of wire having a negligible temperature coefficient. The connections should be made as in Fig. 17.

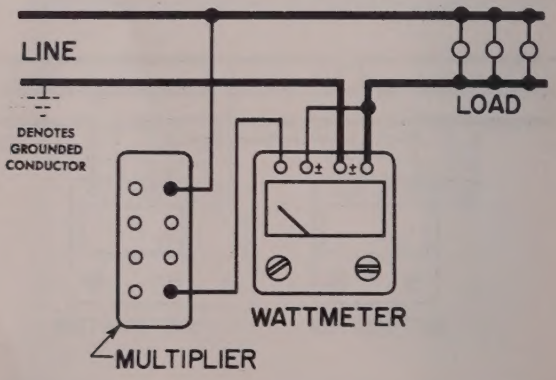


Fig. 17. Multiplier and wattmeter connections

The constant by which the corrected reading should be multiplied to obtain the true watts may be obtained in the following manner:

$$K = \frac{\text{Resistance of the Instrument} + \text{Resistance of the Multiplier}}{\text{Resistance of the Instrument}}$$

Instrument potential transformers are recommended for use on circuits of over 300 volts. The use of potential and current transformers is strongly urged on circuits of 750 volts and over, or where conditions are hazardous.

MAINTENANCE

To clean the plastic window, wash it with soap and water. To remove grease or oil, use kerosene sparingly. DO NOT use acetone, benzene, carbon tetrachloride, fire-extinguisher fluids, lacquer thinners, or window sprays containing these solvents, since they will smear and soften the window.

It is recommended that the window be wiped or blotted periodically with a clean damp chamois. Do not rub the window with a dry cloth as this is likely to cause scratches and to build up an undesireable electrostatic charge. After cleaning, an antistatic agent such as Anstac "M"* may be applied to the window.

If the window becomes scratched due to handling, the scratches may be removed or considerably reduced by applying a good auto-body cleaner. After the scratches are removed, wash off the cleaner and again apply an antistatic agent to the window.

* Obtain from Chemical Development Corporation, Danvers, Mass.

WHEN YOU NEED SERVICE

IF YOU NEED TO REPAIR, recondition, or rebuild any electric apparatus, a G-E service shop near you is available day and night, seven days a week, for work in the shops or on your premises. Latest factory methods and genuine G-E renewal parts are used to maintain the original performance of your G-E equipment. For full information about these services, contact the nearest service shop or sales office listed below:

APPARATUS SERVICE SHOPS

Allentown, Pa. . . . . 672–676 E. Highland St.
Appleton, Wisc. . . . . Midway Industrial Area, County Trunk, "F"
Atlanta (Chamblee), Ga. . . . . 4639 Peachtree Indus. Blvd.
Baltimore 30, Md. . . . . 920 E. Fort Ave.
Boston (Medford 55, Mass. Mystic Valley Pkwy.
Buffalo 11, N. Y. . . . . 318 Urban St.
Charleston 28, W. Va. . . . . 306 MacCorkle Ave., S.E.
Charlotte, N. C. . . . . 2328 Thrift Road
Chicago 32, Ill. . . . . 4360 W. 47th St.
Cincinnati 2, Ohio . . . . . 444 W. Third St.
Cleveland 4, Ohio . . . . . 4966 Woodland Ave.
Columbus 23, Ohio . . . . . 2128 Eakin Rd.
Corpus Christi, Texas . . . . . 115 Busse St.
Dallas 19, Texas . . . . . 3202 Manor Way
Davenport (Bettendorf, Ia. . . . . 1039 State St.
Decatur, Ill. . . . . 2225 E. Logan St.
Denver 5, Colo. . . . . 3353 Larimer St.
Detroit 2, Mich. . . . . 5950 Third Ave.
Houston 20, Texas . . . . . 5534 Harvey Wilson Drive
Indianapolis 22, Ind. . . . . 1740 W. Vermont St.
Johnstown, Pa. . . . . 841 Oak St.
Kansas City 8, Mo. . . . . 819 E. 19th St.
Los Angeles 1, Calif. . . . . 6900 Stanford Ave.
Louisville, Ky. . . . . 2014 New Main St.
Midland, Tex. . . . . 3404 Bankhead Hwy.
Milwaukee 3, Wisc. . . . . 940 W. St. Paul Ave.
Minneapolis 12, Minn. . . . . 2025 49th Ave., N.
New Orleans, La. . . . . 2815 N. Robertson St.
New York 14, N. Y. . . . . 416 W. 13th St.
Oakland, Calif. . . . . 1525 Peralta St.
Philadelphia 24, Pa. . . . . 1040 E. Erie Ave.
Pittsburgh 6, Pa. . . . . 6519 Penn Ave.
Portland 10, Oregon . . . . . 2727 N.W. 29th Ave.
Richmond 24, Va. . . . . 1403 Ingram Ave.
Roanoke, Va. . . . . 115 Albemarle St.
Sacramento, Calif. . . . . 99 N. 17th St.
St. Louis 10, Mo. . . . . 1115 East Road
Salt Lake City 4, Utah . . . . . 301 S. Seventh West St.
San Francisco 3, Calif. . . . . 1098 Harrison St.
Seattle 4, Wash. . . . . 3422 First Ave., S.
Southington, Conn. . . . . 53 Railroad Ave.
Spokane 3, Wash. . . . . S. 155 Sherman St.
Toledo 4, Ohio . . . . . 1 So. St. Clair St.
Wheeling, W. Va. . . . . 2050 National Rd.
York, Pa. . . . . 54 N. Harrison St.
Youngstown 5, Ohio . . . . . 272 E. Indianola Ave.

APPARATUS SALES OFFICES

Abilene, Texas . . . . . 442 Cedar St.
Akron 8, Ohio . . . . . 535 S. Main St.
Albany 7, N. Y. . . . . 90 State St.
Albuquerque, N. Mex. . . . . 323 Third St., S.W.
Alexandria, La. . . . . 720 Murray St.
Allentown, Pa. . . . . 1132 Hamilton St.
Amarillo, Texas . . . . . Amarillo Bldg.
Appleton, Wisc. . . . . 531 W. College Ave.
Atlanta 3, Ga. . . . . 1860 Peachtree Rd., N.W.
Augusta, Ga. . . . . Masonic Bldg.
Augusta, Me. . . . . 152 State St.
Baltimore 1, Md. . . . . 111 Park Ave.
Bangor, Maine . . . . . 77 Central St.
Baton Rouge 5, La. . . . . 3170 Florida Blvd.
Battle Creek, Mich. . . . . 25 W. Michigan Ave.
Beaumont, Texas . . . . . 1385 Calder Ave.
Billings, Mont. . . . . Rm. 816, 303 No. Broadway
Binghamton, N. Y. . . . . 19 Chenango St.
Birmingham 3, Ala. . . . . 1804 Seventh Ave., N.
Bismarck, N. Dak. . . . . 418 Rosser Ave.
Bluefield, W. Va. . . . . 704 Bland St.
Appalachian Bldg.
Boise, Idaho . . . . . 1524 Idaho St.
Boston 1, Mass. . . . . 140 Federal St.
Buffalo 3, N. Y. . . . . 535 Washington St.
Butte, Mont. P.O. Box 836, 103 N. Wyoming St.
Canton 2, Ohio . . . . . 700 Tuscarawas St., W.
Cedar Rapids, Iowa . . . . . 210 Second St., S.E.
Charleston 28, W.Va. . . . . 306 MacCorkle Ave., S.E.
Charlotte 1, N. C. . . . . 112 S. Tryon St.
Chattanooga 2, Tenn. . . . . 832 Georgia Ave.
Chicago 80, Ill. P.O. Box 5970A, 840 S. Canal St.
Cincinnati 2, Ohio . . . . . 215 W. Third St.
Cleveland 4, Ohio . . . . . 4966 Woodland Ave.
Columbia 1, S.C., P.O. Box 1434, 1420 Lady St.
Columbus 15, Ohio . . . . . 40 S. Third St.
Corpus Christi, Texas . . . . . 205 N. Chaparral
Dallas 2, Texas . . . . . 1801 N. Lamar St.
Davenport (Bettendorf, Ia. . . . . 1039 State St.
Dayton 2, Ohio . . . . . 11 W. Monument Bldg.
Dayton 9, Ohio Avia. & Def., 2600 Far Hills Ave.
Denver 2, Colo. . . . . 650 Seventeenth St.
Des Moines 9, Iowa . . . . . 505 W. Fifth Ave.
Detroit 2, Mich. . . . . 700 Antoinette St.
Duluth 2, Minn. . . . . 14 W. Superior St.
Elmira, N. Y. . . . . Main and Woodlawn Aves.
El Paso, Texas . . . . . 215 No. Stanton
Erie, Pa. . . . . 1001 State St.
Eugene, Ore. . . . . 610 High St.
Evansville 19, Ind. . . . . 123 N.W. Fourth St.
Fairmont, W. Va. . . . . 310 Jacobs Bldg., P.O. Box 1626
Fergus Falls, Minn. . . . . 108 N. Court Ave. P.O. Box 197
Flint 3, Mich. . . . . 653 S. Saginaw St.
Fort Wayne 6, Ind. . . . . 3606 So. Calhoun St.
Fort Worth 2, Tex. . . . . 408 W. Seventh St.
Fort Worth, Tex. Avia. & Def., 6200 Camp Bowie Blvd.
Fresno 1, Calif. . . . . 407 Patterson Bldg. Tulare and Fulton St
Grand Rapids 2, Mich. . . . . 425 Cherry St., SE
Greensboro, N. C. . . . . 301 S. Elm St.
Greenville, S. C. . . . . 108 W. Washington St.
Gulfport, Miss. . . . . 207 Jo-Fran Bldg.
Hagerstown, Md. . . . . Professional Arts Bldg.
Hartford 5, Conn. . . . . 764 Asylum Ave.
Houston 1, Texas . . . . . 1312 Live Oak St.
Indianapolis 4, Ind. . . . . 110 N. Illinois St.
Jackson, Mich. . . . . 120 W. Michigan Ave.
Jackson 1, Miss. . . . . 203 W. Capitol St.
Jacksonville 2, Fla. . . . . 700 E. Union St.
Jamestown, N. Y. P.O. Box 548, 2 Second St.
Johnstown, Pa. . . . . 841 Oak St.
Joplin, Mo. P.O. Box 948, 220½ W. Fourth St.
Kalamazoo 3, Mich. . . . . 112 Portway Ave.
Kansas City 6, Mo. . . . . 106 W. Fourteenth St.
Knoxville 08, Tenn. . . . . 602 S. Gay St.
Lake Charles, La. . . . . 422 Seventh St.
Lansing 8, Mich. 306 Michigan National Tower
Lexington, Ky. . . . . First National Bank Bldg.
Lincoln 8, Nebr. Sharpe Bldg., 206 S. 13th St.
Little Rock, Ark. . . . . 103 W. Capitol Ave.
Los Angeles 54, Calif. . . . . 212 N. Vignes St.
Louisville 2, Ky. . . . . 455 S. Fourth St.
Lubbock, Texas . . . . . 3202 Avenue "A"
Macon, Ga. . . . . 682 Cherry St.
Madison 3, Wisc. . . . . 16 N. Carroll St.
Manchester, N. H. . . . . 875 Elm St.
Medford, Ore., P.O. Box 1349, 205 W. Main St.
Memphis 3, Tenn. . . . . 8 N. Third St.
Miami 32, Fla. . . . . 25 S.E. Second Ave.
Midwest City, Okla. . . . . Avia. & Def., 207 Post Off. Bldg.
Milwaukee 3, Wisc. . . . . 940 W. St. Paul Ave.
Minneapolis 3, Minn. . . . . 12 S. Sixth St.
Mobile 13, Ala. . . . . 54 St. Joseph St.
Nashville 3, Tenn. . . . . 234 Third Ave., N.
Newark 2, N. J. . . . . 744 Broad St.
New Haven 6, Conn. . . . . 129 Church St.
New Orleans 12, La. . . . . 837 Gravier St.
New York 22, N. Y. . . . . 570 Lexington Ave.
New York . . . . . Avia. & Def., Fed. Bldg., N. Y. International Airport, Jamaica 30, N. Y.
Niagara Falls, N. Y. . . . . 253 Second St.
Norfolk 10, Va. . . . . 229 W. Bute St.
Oakland 12, Calif. . . . . 409 Thirteenth St.
Oklahoma City 2, Okla. . . . . 119 N. Robinson St.
Omaha 2, Nebr. . . . . 409 S. Seventeenth St.
Pasco, Wash. . . . . 824 W. Lewis St.
Peoria 2, Ill. . . . . 309 Jefferson Bldg.
Philadelphia 2, Pa. . . . . 1405 Locust St.
Phoenix, Ariz. P.O. Box 4037, 303 Luhrs Tower
Pittsburgh 22, Pa. The Oliver Bldg., Mellon Sq.
Portland 7, Ore. . . . . 920 S.W. Sixth Ave.
Providence 3, R. I. . . . . Industrial Trust Bldg.
Raleigh, N. C. . . . . 336 Fayetteville St.
Reading, Pa. . . . . 31 N. Sixth St.
Richmond 17, Va. . . . . 700 E. Franklin St.
Riverside, Calif. . . . . 3570 Ninth St.
Roanoke 16, Va. . . . . 920 S. Jefferson St.
Rochester 4, N. Y. . . . . 89 E. Ave.
Rockford, Ill. . . . . 110 S. First St.
Rutland, Vt. . . . . 38½ Center St.
Sacramento 14, Calif. . . . . 626 Forum Bldg.
Saginaw, Mich. . . . . Second National Bank Bldg.
St. Louis 1, Mo. . . . . 818 Olive St.
Salt Lake City 9, Utah . . . . . 200 S. Main St.
San Antonio 5, Texas . . . . . 434 So. Main Ave.
San Diego 1, Calif. . . . . 1240 Seventh Ave.
San Francisco 6, Calif. . . . . 235 Montgomery St.
San Jose 10, Calif. . . . . 460 Park Ave.
Savannah, Ga. . . . . 4 E. Bryan St.
Seattle 4, Wash. . . . . 710 Second Ave.
Seattle 8, Wash. Avia. & Def., 220 Dawson St.
Shreveport, La. . . . . 910 Shelby Bldg.
Sioux City 13, Iowa . . . . . 572 Orpheum Electric Bldg.
South Bend 1, Ind. . . . . 112 W. Jefferson Blvd.
Spokane 4, Wash. . . . . S. 162 Post St.
Springfield, Ill. . . . . 607 E. Adams St.
Springfield 3, Mass. . . . . 1387 Main St.
Stockton, Calif. . . . . 11 So. San Joaquin St.
Syracuse 6, N. Y. . . . . 3532 James St.
Tacoma 1, Wash. . . . . 1202 Washington Bldg.
Tampa 6, Fla. . . . . 1206 North A St.
Toledo 4, Ohio . . . . . 420 Madison Ave.
Trenton 8, N. J. . . . . 214 E. Hanover St.
Tucson, Ariz. P.O. Box 710, 650 N. Sixth Ave.
Tulsa 3, Okla. . . . . 320 S. Boston Ave.
Utica 2, N. Y. . . . . 258 Genesee St.
Washington 3, D. C. . . . . 777–14th St., N.W.
Waterloo, Iowa . . . . . 206 W. 4th St.
Wenatchee, Wash. 328 N. Wenatchee Ave.
Wheeling, W. Va. . . . . 40 Fourteenth St.
Wichita 2, Kan. . . . . 200 E. First St.
Williamston, N. C. . . . . 115 E. Main St.
Worcester 3, Mass. . . . . 288 Grove St.
York, Pa. . . . . 56 N. Harrison St.
Youngstown 5, Ohio . . . . . 272 E. Indianola Ave.

Hawaii: American Factors, Ltd., P. O. Box 3230, Honolulu 1 Canada: Canadian General Electric Company, Ltd., Toronto

INSTRUMENT DEPARTMENT, GENERAL ELECTRIC COMPANY, WEST LYNN, MASS.

5-56 (1M)

PRINTED IN U.S.A.